High Performance Computing OpenStack Options

September 22, 2015

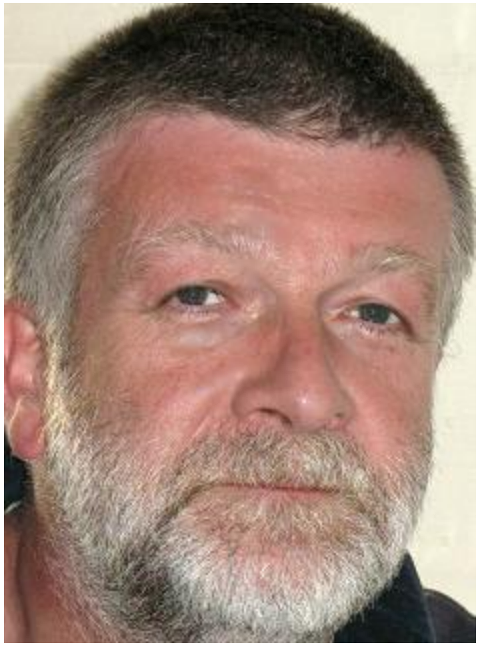
SNIA™

Cloud Storage Initiative

Today's Presenters

Glyn Bowden, SNIA Cloud Storage Initiative Board HP Helion Professional Services

Alex McDonald, SNIA Cloud Storage Initiative Chair - NetApp



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Abstract

Organisations are beginning to look to OpenStack to provide framework and tenancy controls around HPC workloads. The greatest gain in the multi-tenancy model is also the greatest challenge for storage; how to provide, reliable, high performance storage that is adequately segregated for the workloads in a cloud environment.

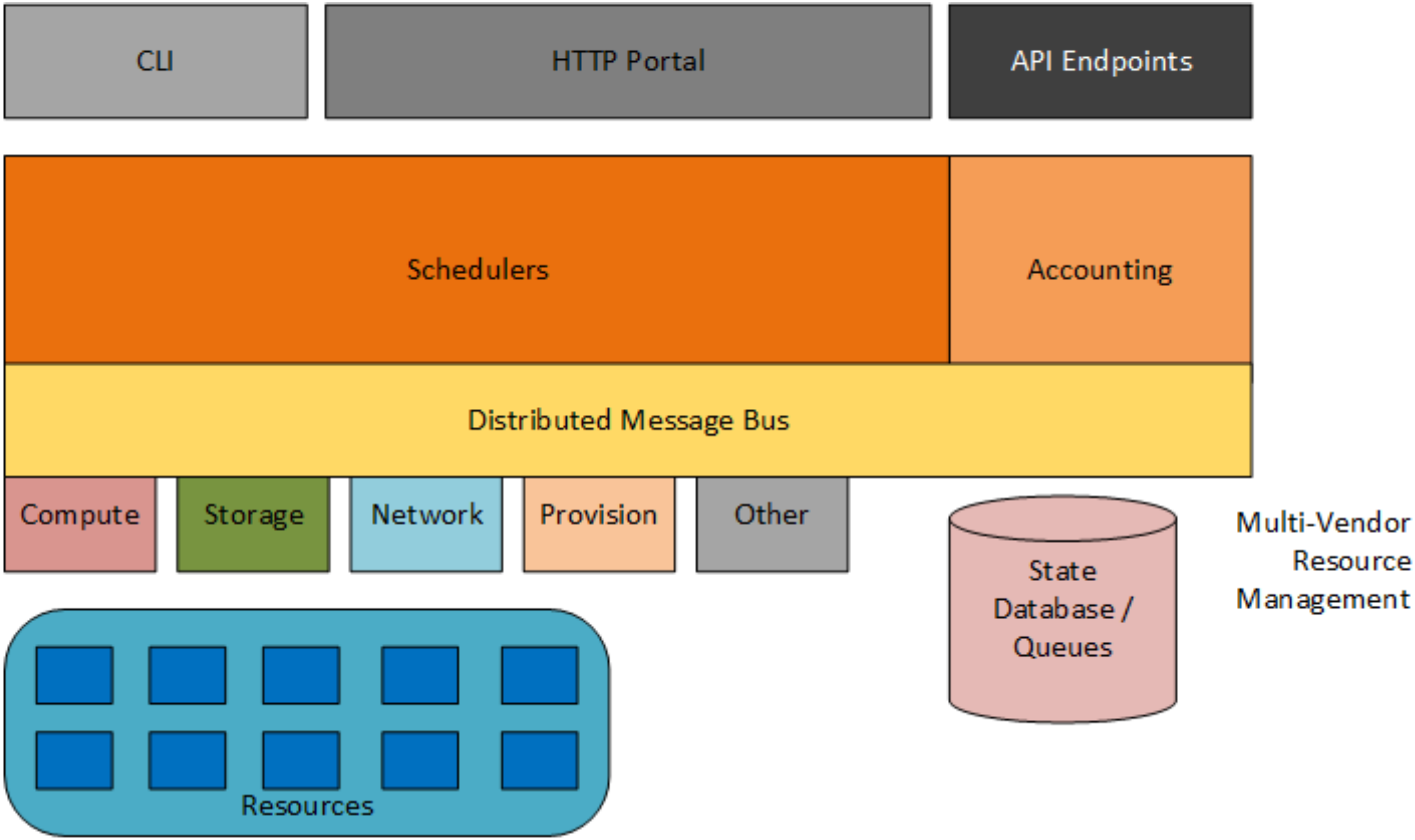
This presentation looks at the options available within OpenStack and the Cloud Storage community.

Agenda

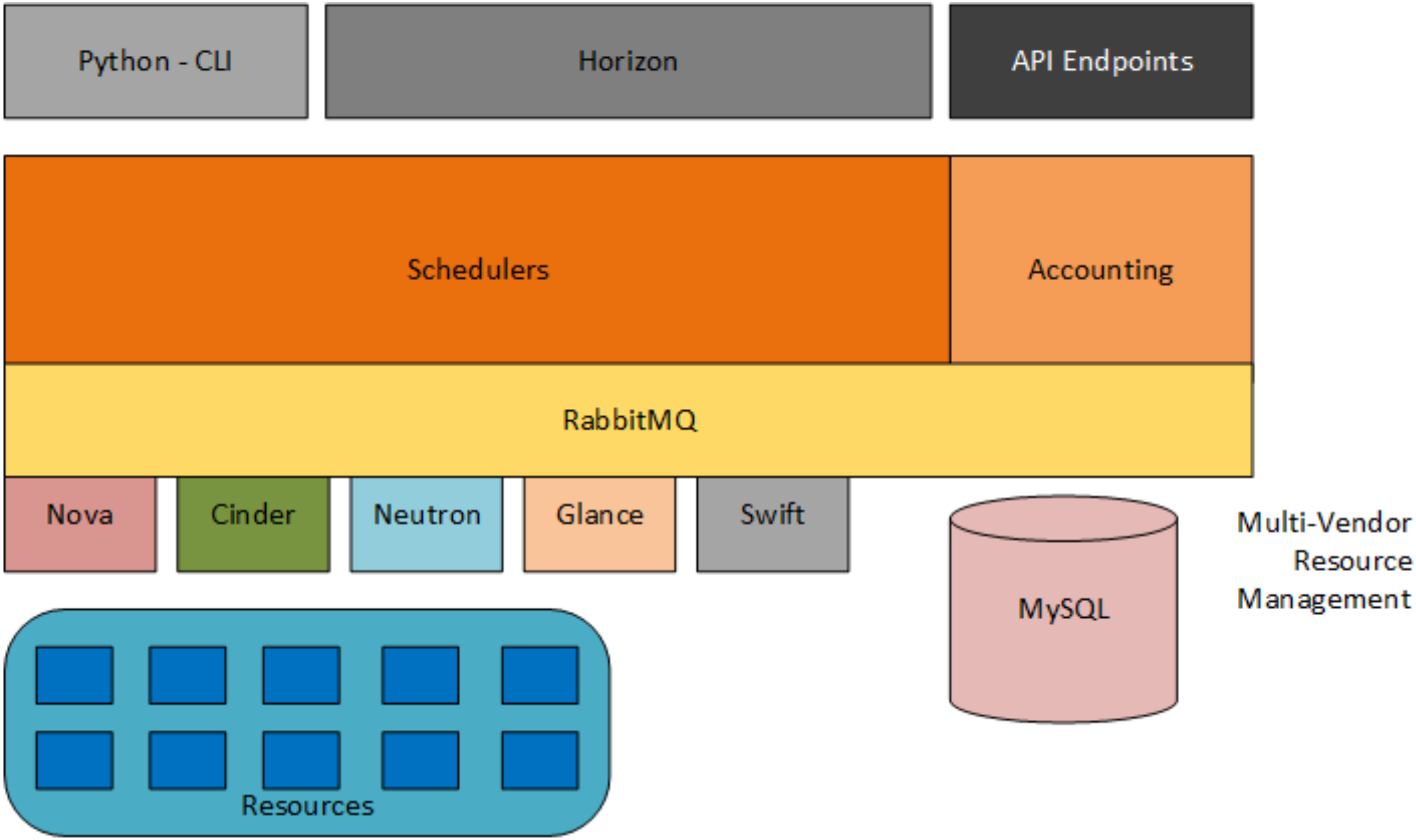
- HPC vs OpenStack
- What is “High Performance Compute”
- Specific Challenges
- Storage Options
  - Block
  - Object
  - File
- Example Scenario
- Summary

HPC VS OPENSTACK

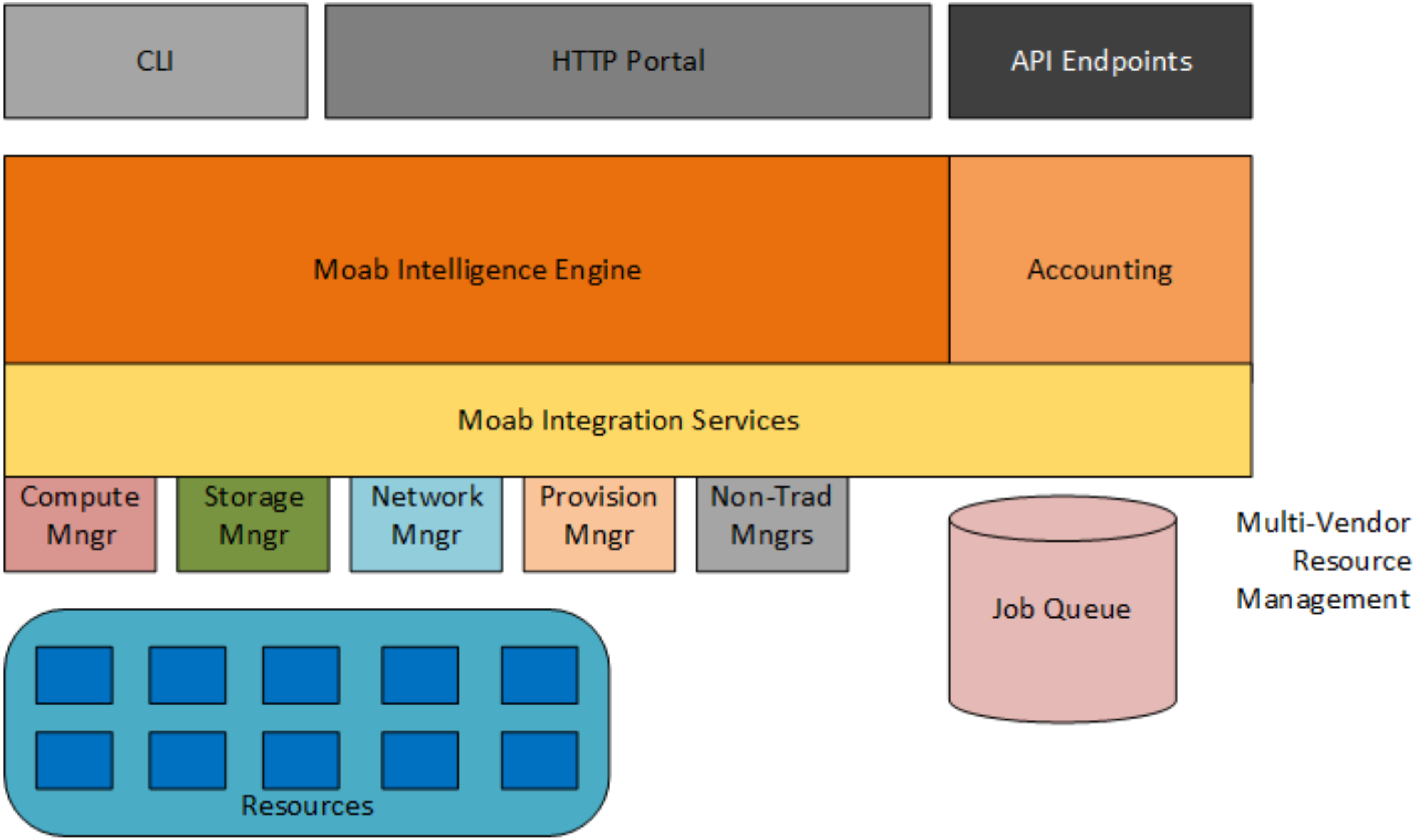
The logical architecture



..of OpenStack



..and MOAB HPC Suite



HPC and OpenStack – Opposing Forces

- Cloud
  - Share Everything
  - Generic Workloads
  - Loosely Coupled
  - Many small workloads

HPC and OpenStack – Opposing Forces

- Cloud
  - Share Everything
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  - Many small workloads

- HPC
  - Share Nothing
  - Specific, Niche Workloads
  - Tightly Coupled (RDMA)
  - Few Large Distributed Workload

But the same…

- Cloud
  - Highly Distributed
  - Large Storage Pools
  - Resource Management Key
  - Performance Management

- HPC
  - Highly Distributed
  - Large Storage Pools
  - Resource Management Key
  - Performance Management

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WHAT IS HIGH PERFORMANCE COMPUTING?

Background on HPC

- Two Major Types of HPC
  - **Analytics**
  - Big Data Sets
  - Simple Operations repeated many times
  - Aggregation of results
  - **Computationally Intensive**
  - Smaller Data Sets
  - Very complex algorithms that need to be broken down
  - Sequential processing and summary
  - Often Latency Sensitive (RDMA, Lustre) or Bandwidth Sensitive (High Volume Filesystems, Large Files)

Background on HPC

- Two types of Computational HPC
  - **Batch Processing**
  - Loosely coupled
  - Embarrassingly Parallel
  - Limited / No shared resources during jobs
  - **Realtime / Grid Computing**
  - Tightly Coupled
  - Requires High Performance Networking for Remote Direct Memory Access (RDMA)
  - Usually a high performance shared file system is required
  - CPU and Memory Architecture more critical than batch

Why HPC and OpenStack

THE CHALLENGES

The Challenges

- Resource Management
  - HPC clusters have always been very good at managing their own resources
  - Challenge comes when security and multi-tenancy is required
- Multi-Tenancy Drivers
  - Genome Research driving separation
  - Human data cannot be shared beyond proposed use
  - Projects use flexible resources but on a fixed hardware platform

Storage Options

EPHEMERAL STORAGE

Ephemeral Storage

- What is it?
  - Persists only as long as the VM exists
  - Usually located locally on the compute server
- HPC Use Cases?
  - User scratch space
  - Work scratch space
  - Operating Environment

Storage Options

BLOCK STORAGE

Block Storage

- What is it?
  - Persistent, non-shared block storage
  - Can be provided by many sources, SAN Arrays, Local Disk etc.
- HPC Use Cases?
  - Supporting Databases
  - High performance scratch space
- OpenStack Project is CINDER
  - A Large Disk Array attached by Fibre Channel SAN to all of the compute nodes
  - OpenStack uses Cinder drivers to create, mount and protect LUNs for the guests.
  - Guest is responsible for creating a file system on those LUNs
  - Not shared with other guests

Storage Options

OBJECT STORAGE

Object Storage

- What is it?
  - Persistent, scalable storage pools
  - Access using a REST based API
  - Not bound to an individual Guest
- HPC Use Cases?
  - Centralised Data Lakes
  - Archives / Backups of source data
- OpenStack Project is Swift
  - Usually uses large pools of local disk attached directly to the object servers
  - Uses metadata to index the data and locate object blocks from unique identifiers
  - Lots of plugins for the various analytics engines that are expanding the adoption of object as a centralised data lake

Storage Options

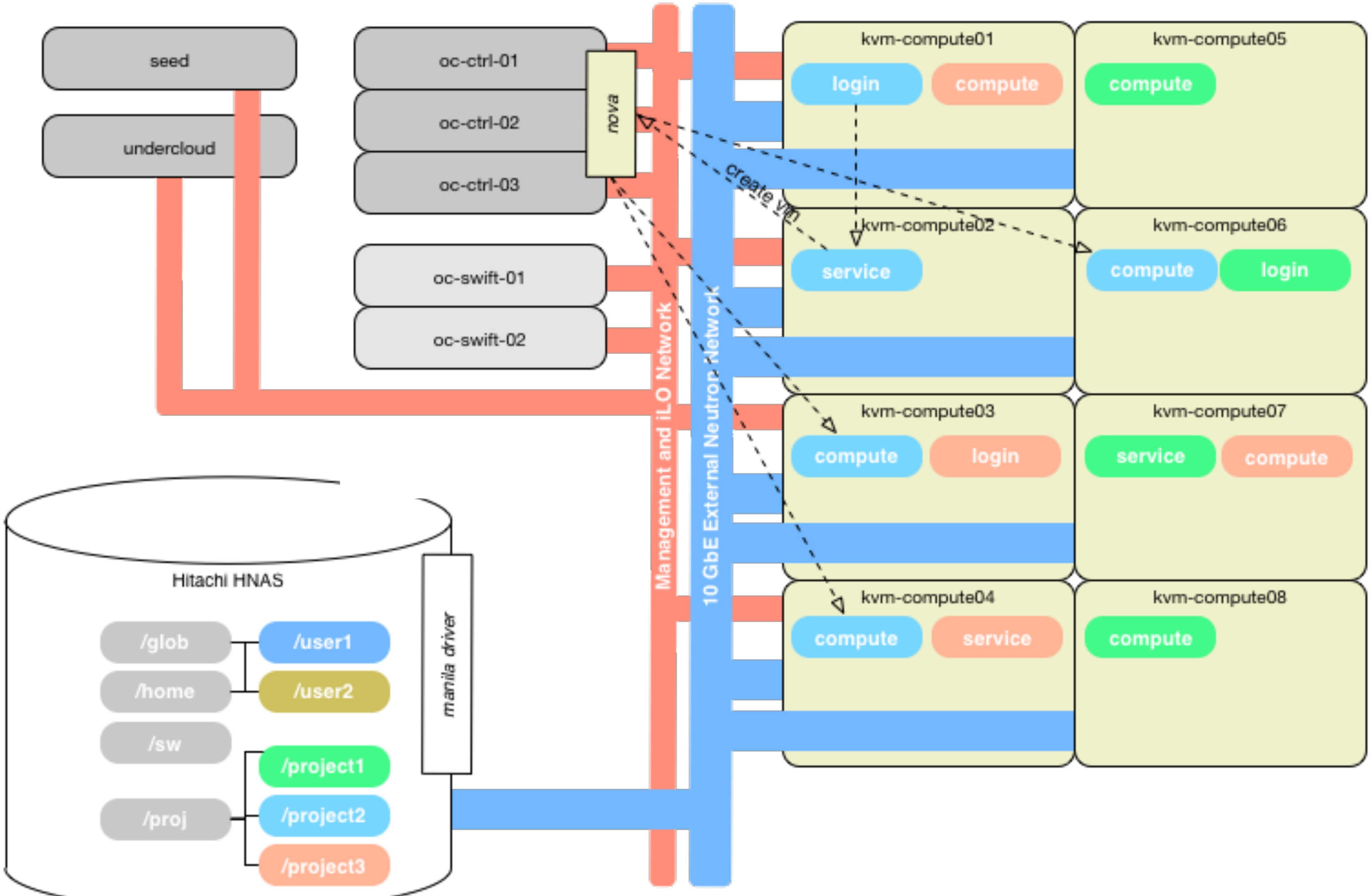
FILE STORAGE

File Storage

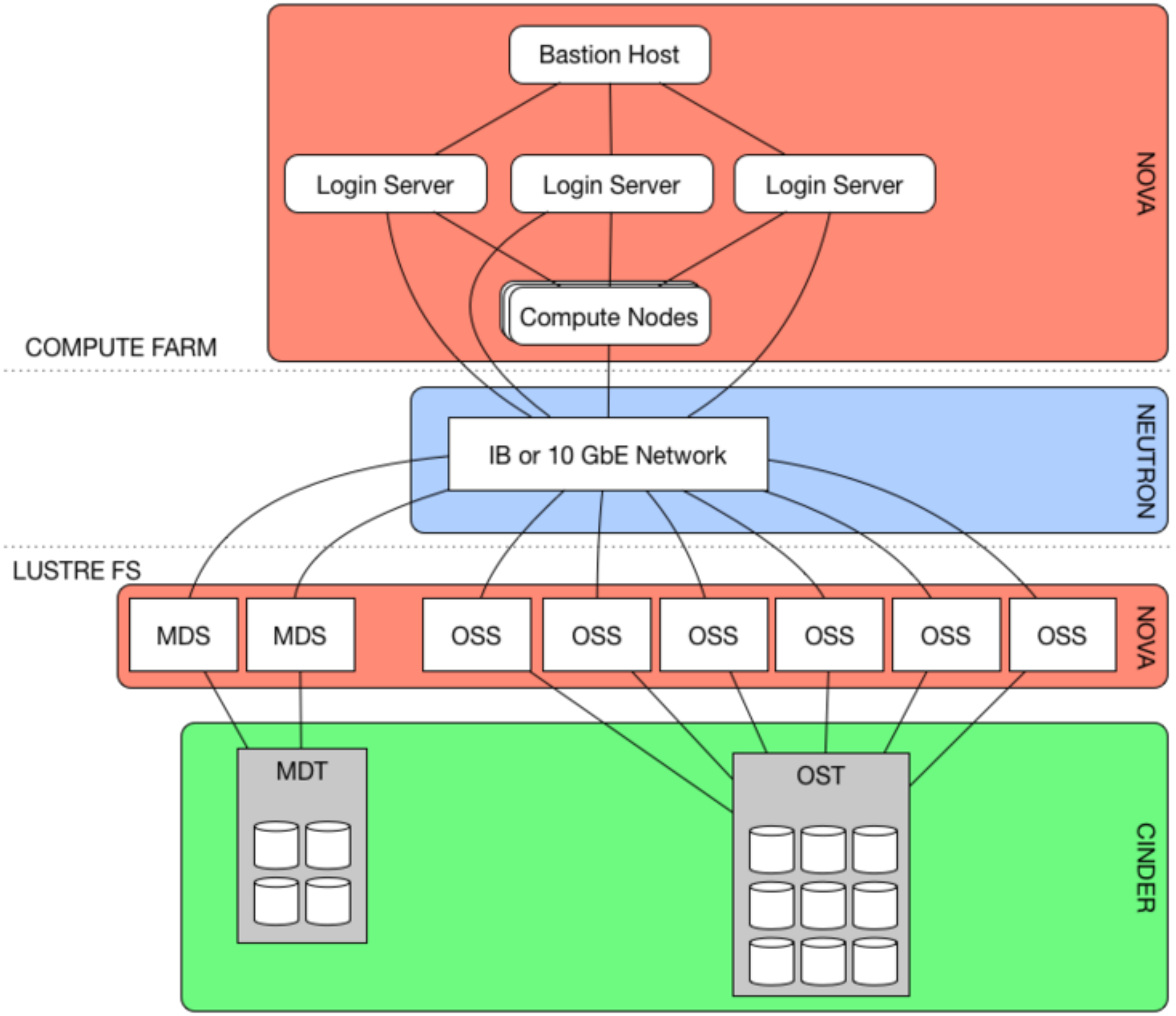
- What is it?
  - Shared, persistent storage
  - Uses standard POSIX file system methods to access data
- HPC Use Cases?
  - User Home Directories
  - Shared Project Data
  - Scale out file systems!
- OpenStack Project is Manila
  - Manage the creation of storage pools on the provider service
  - Create the shares and apply the correct permissions
  - Mount those shares within the guests that need them
  - Can be NFS or CIFS based today
  - Plugin driven

AN EXAMPLE SCENARIO

Storage Use Case



OpenStack and Lustre Mapping



Lustre as a Service Stack

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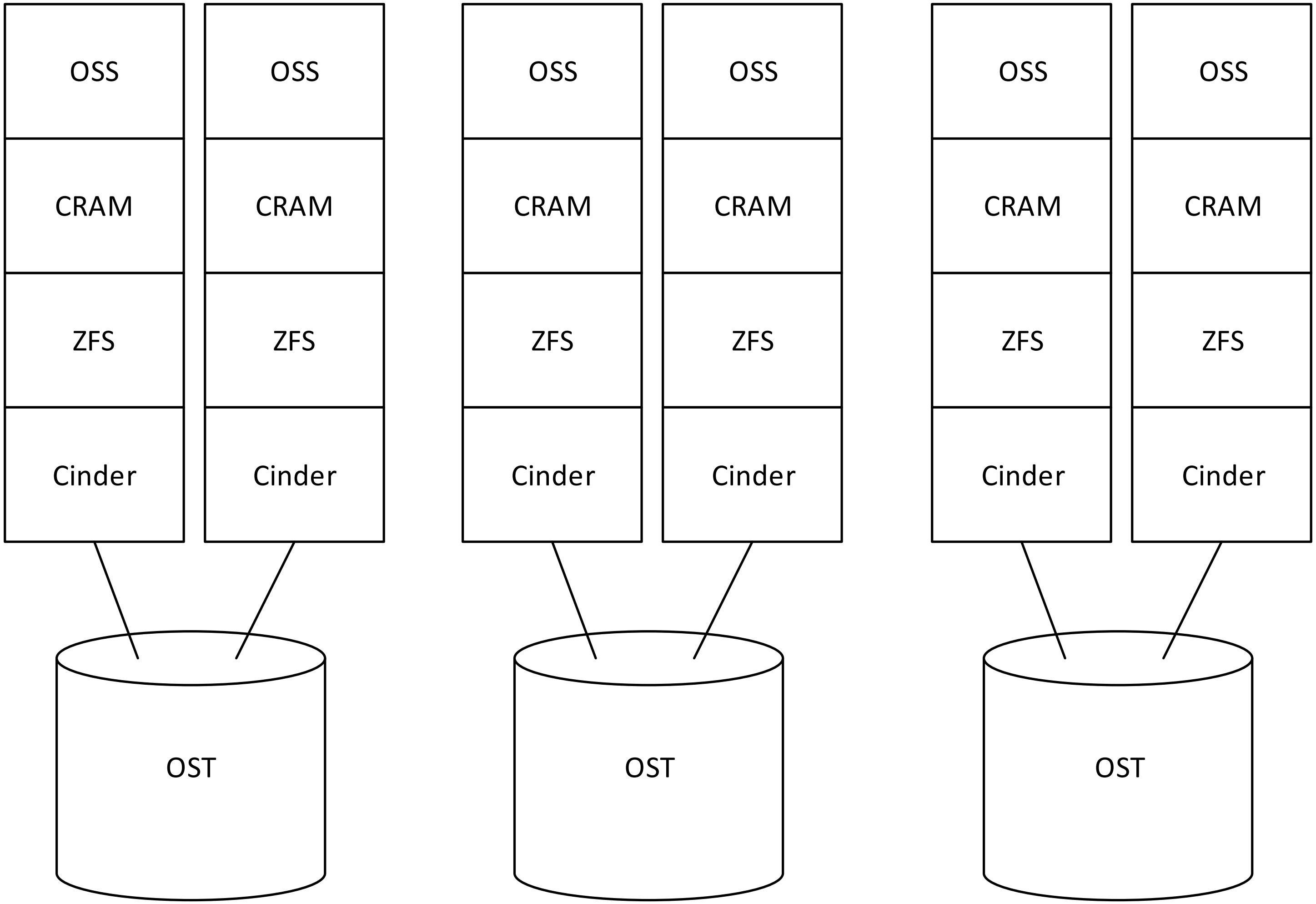

Lustre Components

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- Massively Parallel Filesystem made up of key components…
  - MGS – Management Server
  - MGT – Management Target
  - MDS – Meta Data Server
  - MDT – Meta Data Target
  - OSS – Object Storage Server
  - OST – Object Storage Target
- 1 File can be spread over up to 2000 objects
- With ldiskfs, each of those each object can be up to 16 TB
- That's 31.25 PB (Yes PETA bytes) for a single file using ldiskfs
- Up to 4 Billion files per MDT
- Up to 4096 MDTs!

What about ZFS? Why?

- Lustre has limited data protection.
  - RAID 0
  - Protection from Physical Infrastructure
- Scale Out – Easy, Scale UP – Hard
- ZFS has healing, snapshots (not necessarily a good idea here) and scale up!
- ZFS Cache Pools for Meta-Data or even data sets, huge acceleration potential
- Scale…

Lustre + ZFS File Limits

	LDISKFS	ZFS
Object Size	16 TB	256 PB
Maximum File Size	21.25 PB	8 EB (2^63)
Max Files per MDT	4 Billion	4 Billion
Max MDTs	4096	4096

Work in Progress

- Lustre can be for high bandwidth and low latency
- Low latency challenging in virtual environment
- High Bandwidth, easier (not simple though)
- Use OpenStack tools to provision Lustre Components
- Build small scale, segregated clusters for multi-tenancy
- Export via NFS with Manila on private networks
- Include ZFS and Compression
- Use Cinder Block for the shared storage element

SUMMARY

Summary

- Initial interest of HPC on OpenStack is being driven by tenancy requirements
- Managing flexible HPC resources has been tricky, OpenStack makes that easier for HPCaaS
- Many areas are needed to work well together for success, OpenStack Community beginning to address that as we have seen.
- HPC on OS is a reality and many are pushing the boundaries and committing back to the community.

After This Webcast

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- This webcast and a copy of the slides will be posted to the SNIA-CSI website and available on-demand
  - http://www.snia.org/forum/csi/knowledge/webcasts
- A full Q&A from this webcast, including answers to questions we couldn't get to today, will be posted to the SNIA Cloud blog
  - http://www.sniacloud.com/
- Follow us on Twitter @SNIACloud
- Upcoming SNIA Webcast: OpenStack Manila – Oct. 7th
  - https://www.brighttalk.com/webcast/663/173013
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Conclusion

Questions

Conclusion

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Thank You